

IN THE U.S. PATENT AND TRADEMARK OFFICE

In re application of

Harald KRAUS et al.

Conf. 2464

Application No. 10/588,766

Group 1792

Filed August 8, 2006

Examiner Roberts Culbert

METHOD FOR SELECTIVE ETCHING

PRE-APPEAL BRIEF REQUEST FOR REVIEW

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

November 16, 2009

Sir:

Applicants request review of the final rejection in the above-identified application. No amendments are being filed with this request.

A Notice of Appeal is filed herewith.

The review is requested for the reasons advanced on the attached sheets.

Respectfully submitted,

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REASONS IN SUPPORT OF REQUEST FOR REVIEW

A pre-appeal brief review is respectfully requested because the rejections include at least a clear factual error, or in the alternative, a clear legal error, as explained below.

Claims 3-5, 8, 11-15 and 17 are not unpatentable under 35 U.S.C. §103(a) over CHRISTENSON (US 2003/0235985) in view of TANAKA (US 5,032,217) and further in view of BUCHANAN (US 2003/0230549). The position of the Official Action is based on at least two erroneous interpretations of CHRISTENSON: (I) CHRISTENSON suggests optimization of the process parameters to approach the claimed flow velocity, and (II) CHRISTENSON teaches using HfO_2 and ZrO_2 . These factual errors are explained in detail below.

I. CHRISTENSON fails to suggest optimization of process parameters to approach the claimed flow velocity.

CHRISTENSON describes the etching process in general terms in paragraph [0042]:

“The etching process(es) and solution(s) can be used in any equipment where the etching solution is able to contact and etch the high k-material. For instance, the wafers with the high-k material can be immersed in a bath of the etching solution, either static, cascading or otherwise flowing, as in a wet bench.” (Emphasis added.)

That is, for process parameters, CHRISTENSON discloses that any equipment is suitable and that the etching solution may have no flow velocity (i.e., static or no volumetric flow rate) or a flow velocity greater than zero (i.e., cascading or flowing at a volumetric flow rate greater than zero).

CHRISTENSON illustrates this general description with a specific example (par. [0043]):

"The similarity between the etch results noted below in the examples utilizing a small , static volume of etching solution and a centrifugal spray processor with high cross-wafer flow rates indicates that the flow rate of etching solution over the wafer is not critical." (Emphasis added.)

Table 5 shows similar results for immersion (no flow velocity) and spraying a volumetric flow of unknown velocity:

TABLE 5				
Etch rates in Å/min of various films immersed in etchant and in a spray processor.				
	$Zr_xSi_yO_x$	$Hf_xSi_yO_x$ (60%)	$Hf_xSi_yO'_x$ (80%)	TEOS
0.049 wt % HF - Immersion	>29.6	25	14.8	5.0
0.04 wt % HF - Spray	80	68.0	14.8	9.9
0.0049 wt % HF - Immersion	>8.1	1.4	0.2	0.09
0.0049 wt % HFF - Spray	12.7	1.9	0.3	0.1

Accordingly, CHRISTENSON discloses that a volumetric flow rate greater than zero produces equivalent results to no volumetric flow, both in general terms and by example.

In view of the above, CHRISTENSON fails to suggest that optimization of either the equipment, method (static bath or spray) or volumetric flow rate, which is related to flow velocity(i.e., there can be no flow velocity without a volumetric flow rate), could be carried out to achieve a desired effect.

Thus, as CHRISTENSON fails to recognize process parameters, including volumetric flow rate (and thus flow velocity), as a result-effective variable of the etching process, it would have been unobvious to modify process parameters to approach the claimed flow velocity.

This is in contrast to the claimed invention, where the cross-wafer flow rate of etching solution is deemed critical.

**II. CHRISTENSON teaches away
from using either HfO₂ or ZrO₂.**

The objective of CHRISTENSON is to etch high-k films in an effective, controllable and repeatable manner. CHRISTENSON accomplishes this objective using an etching composition that "is an aqueous solution that comprises an unconventionally dilute concentration of one or more fluoride species." (par.[0013])

In paragraph [0022], CHRISTENSON discloses that etching materials with one elemental constituent other than oxygen are highly resistant to dilute etching compositions, compared to etching materials having least two elemental constituents:

[0022] It has been discovered that dielectric materials comprising at least two elemental constituents in addition to any optional oxygen may be favorably etched using the dilute fluoride containing etching solutions of the present invention. While not wishing to be bound by theory, it is believed that the favorable etch characteristics are related to the crystalline structure of the high-k dielectric films. Conventionally, a unary high-k dielectric material, i.e., a material comprising only one elemental constituent other than oxygen (e.g., HfO_2 and ZrO_2), are highly resistant to dilute etchants. However, it is believed that incorporating at least two elemental constituents in addition to optional oxygen disrupts the crystalline lattice to a sufficient degree such that the material is more susceptible to etching.

The preferred materials are generally described as:

[0024] A wide variety of dielectric materials may be used as high-k dielectric materials of the invention. In some embodiments, preferred high k dielectric materials comprise at least two constituents selected from Zr, Hf, Si, Ge, Y, As, N, and Al. In such embodiments, the material may further comprise additional non-metal constituents such as B, P, combinations of these, and the like. In some embodiments, if the material comprises both Si and N, it is further preferred that such embodiments further comprise at least one additional constituent such as Zr, Hf, Ge, Y, As, B, P, combinations of these, or the like.

Specific materials include (par. [0025] and [0026]):

$\text{M}_x\text{Si}_y\text{O}_z$, wherein M is one or more metals, y has a value such that the silicate comprises 10% to 90%, preferably 10% to 50% mole fraction Si compared to the other metal(s), and x and z are selected to satisfy stoichiometry. Such silicates optionally may also include one or more additional constituents, as desired, of which B, P, Y, As, Ge, N, Al, combinations of these, and the like are representative.

[0026] Specific examples of silicates include, e.g., HfSiO_4 (k=12), ZrSiO_4 (k=13), $\text{Hf}_{0.6}\text{Si}_{0.4}\text{O}_2$ (k of about 14, commonly referred to as HfSiO (40%)), combinations of these, and the like. Other examples of combinations of elemental oxides include $\text{Zr}_x\text{Hf}_y\text{O}_z$, $\text{Hf}_x\text{Al}_y\text{O}_z$, and $\text{Zr}_x\text{Al}_y\text{O}_z$, where the ratio of z:y preferably is in the range of 1000:1 to 1:1000 and x satisfies stoichiometry. Some other materials under consideration as silicates or in combination with other metals are listed by "A Thermodynamic Approach to Selecting Alternative Gate Dielectrics," by D. G. Schlom, MRS Bulletin, 27 (3), 198-204, (2002).

Thus, one of ordinary skill in the art would have been strongly discouraged from selecting a *first material* on a

substrate, wherein said first material is HfO_2 or ZrO_2 , as presently claimed, for the purpose of CHRISTENSON. One would have expected that such materials would have been resistant to the highly dilute etching compositions of CHRISTENSON due to the presence of only one elemental constituent (Zr or Hf) other than oxygen, and, thus, rendered the process of CHRISTENSON unsatisfactory for its intended purpose.

Conclusion

As CHRISTENSON fails to teach or suggest that for which it was offered, the combination with TANAKA and BUCHANAN does not teach the claimed invention.

Indeed, BUCHANAN, which is the closest prior art, teaches HfO_2 , ion-bombardment, and selective wet etching, but BUCHANAN fails to remedy the shortcomings of CHRISTENSON for references purposes. For example, BUCHANAN fails to disclose or suggest a functional effect of the flow velocity on the selectivity. Also, as discussed above, one of ordinary skill in the art would have been discouraged from including HfO_2 , as taught by BUCHANAN, in the material of CHRISTENSON in view of the dilute solutions required by CHRISTENSON.

Therefore, as the rejection of record includes clear factual and/or legal errors, withdrawal of the rejection and allowance of this application are respectfully requested.